

22. STUDIES ON THE GENUS *HERBERTUS* GRAY FROM MEGHALAYA, INDIA¹AJIT PRATAP SINGH², VIRENDRA NATH^{3,4} AND A.K. ASTHANA^{3,5}¹Accepted May 13, 2006²Department of Botany, Lucknow University, Lucknow 226 007, Uttar Pradesh, India. Email: ajitpsingh2000@rediffmail.com³Bryology Laboratory, National Botanical Research Institute, Lucknow 226 001, Uttar Pradesh, India.⁴Email: drvirendranath2001@rediffmail.com⁵Email: drakasthana@rediffmail.com**Introduction**

Herbertus Gray, a sole member of the Family Herbertaceae K. Muller from India is quite distinct in having hamato-secund 1/2-3/5 bilobed, long, narrowed, acuminate leaves; vitta cells elongate extending into the lobes (Schuster 1972, 1984). However, the genus *Herbertus* Gray was earlier treated under Family Ptilidiaceae Limpr., along with another genus *Trichocolea* Dumort. (Evans 1939). Earlier study on the genus *Herbertus* Gray in India was made by Mitten (1860-1861), Stephani (1909, 1922), Chopra (1938, 1943), Abeywickrama (1959), Miller (1965), Bonner (1966), Hattori (1966, 1971, 1975) and Herzog (1939), where most of the species were described from the eastern Himalayas. Udar and Srivastava (1977) described four species, namely *H. pinnata* (Steph.) Miller, *H. capense* (Steph.) Sim., *H. nilgerriensis* (Steph.) Miller and *H. sanguinea* (Mont.) Aust., from southern India. Parihar *et al.* (1994) listed 22 species, however, Kumar and Manocha (2000) while describing a new species *H. udarii* Kumar *et Manocha* from Darjeeling (eastern Himalayas) have mentioned only 23 species of *Herbertus* Gray in India. During the study on the liverworts of Meghalaya the presence of five taxa in Khasi Hills (Fig. 1) has been revealed. Amongst them *Herbertus fragilis*, *H. ceylanicus* and *H. sikkimensis* are being reported here from the Meghalaya for the first time. A considerable morphological plasticity among plant populations and species is discussed including remarks on distribution and ecology. A key to the species of the genus has also been provided.

The plant specimens were collected during April 1965, November 1998 and September 2000 from heavily moist localities, namely Elephant falls and Langkyrdum on Dawki road, Shillong (East Khasi Hills) Meghalaya. The specimens from various localities have been critically studied and compared with their paratype specimens obtained on loan from Field Museum Herbarium, USA. The collected specimens have been deposited in Bryophyte Herbarium, National Botanical Research Institute, Lucknow (LWG).

KEY TO THE SPECIES OF THE GENUS *HERBERTUS* GRAY IN MEGHALAYA

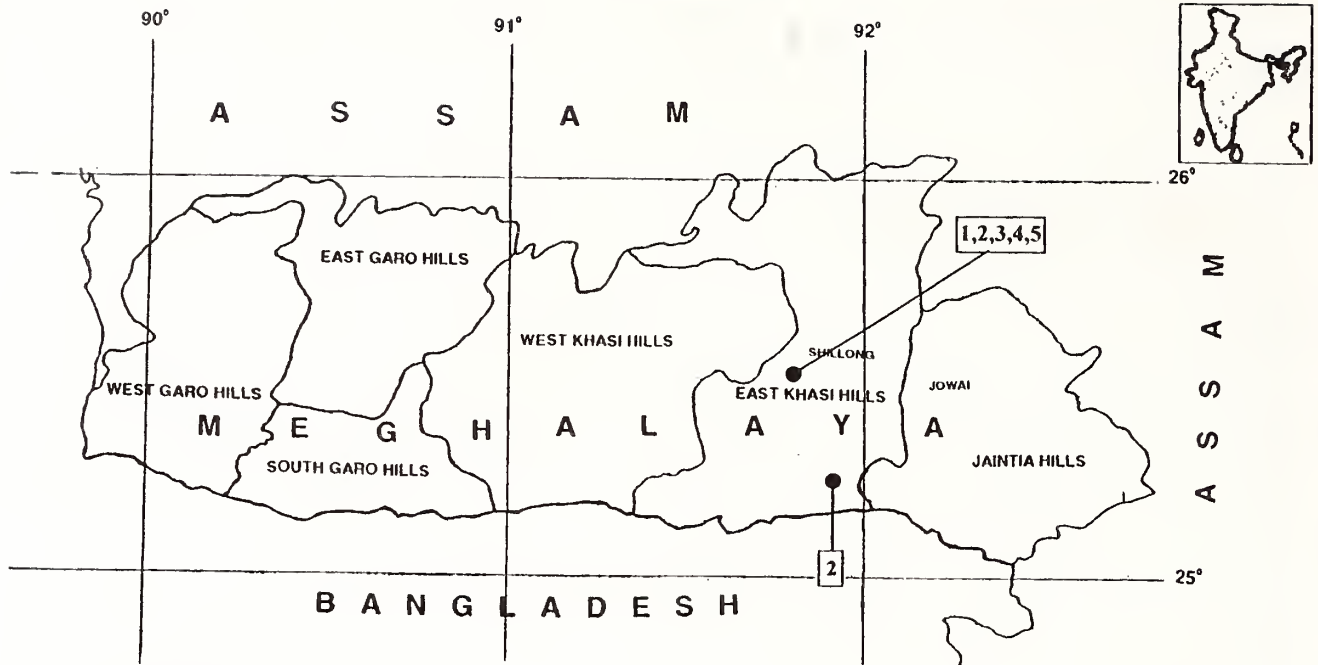
1. Leaves bifid 1/2 or less 2
— Leaves bifid 3/5 or more 3

2. Leaves larger, 1.75-1.88 mm long and 0.75-0.80 mm wide *H. sikkimensis*
— Leaves smaller, 0.60-0.70 mm long and 0.15-0.18 mm wide 4
3. Leaves wider (0.83 mm wide), margin undulate with a lateral constriction at the junction of basal disc and lateral margin, vitta almost extending slightly above the leaf sinus furcation *H. dicranus*
— Leaves less wider (0.53-0.70 mm wide), margin convex or rarely undulate without constriction, vitta almost extending to become the segment tip *H. mastigophoroides*
4. Leaves sinus lunate, lobes more divergent, vitta almost to the base and extending to just below the tip *H. fragilis*
— Leaves sinus obtuse-subacute, lobes obtuse-subacute, vitta almost to the base and extending to just slightly above the leaf sinus furcation *H. ceylanicus*

Herbertus sikkimensis (Steph.) Nichols., Miller, H.A., *J. Hattori Bot. Lab.* 28: 307 (1965); In Handel-Mazzetti *Symbolae Sinicae* 5: 28, 1930. (Figs 1, 2)

Plants medium-large, yellowish green or very light brownish green, 25-30 mm long and 2.50-2.75 mm wide including leaves. Stem 0.28 x 0.17 mm in diameter and 12-13 celled across; cortical cells in 2-3 layers, thick walled, smaller, 5.0 x 7.5 µm; medullary cells thin walled, smaller, 12.5 x 25.0-27.5 µm; frequently branched, branches with numerous attenuated flagelliform ventral intercalary branches. Leaves secund, bifid about 1/2 with acute-subacute, 1.15-1.25 mm deep sinus, nearly sinuately inserted, rigid, suberect-spreading, lobes lanceolate, acute-acuminate, margin entire, occasionally incurved, leaf lobes 1.75-1.88 mm long and 0.75-0.80 mm wide; leaf marginal cells 10.0-15.0 x 17.5 µm, smooth, rather thin walled, trigonous; median cells 12.5-15.0 x 17.5-20.0 µm, thin walled, with nodulose trigones; vitta cells elongated, thin walled, 17.5 x 37.5-57.5 µm, distinct large nodular trigones; vitta furcate, usually only for a short distance or 1/2 into the lobes. Underleaves greatly resembling the leaves; generally transversely inserted, 1.13-1.63 mm long and 0.68-0.70 mm wide, sinus subacute, 0.88-1.03 mm deep, suberect, lobes lanceolate, acute-acuminate, entire, with occasionally incurved margin.

Distribution and ecology: INDIA: North-eastern Himalaya: Meghalaya: East Khasi Hills: Elephant falls. Plants grow on bark in association with *Spruceanthus* sp., at 1,798 m altitude, 23.2 °C temperature and 74% relative humidity.



1. *Herbertus sikkimensis* (Steph.) Nichols.
2. *Herbertus dicranus* (Tayl.) Trev.
3. *Herbertus mastigophoroides* Miller
4. *Herbertus fragilis* (Steph.) Miller
5. *Herbertus ceylanicus* (Steph.) Miller

Fig. 1: Distribution of the genus *Herbertus* Gray in Meghalaya, India

Specimens Examined: INDIA: Meghalaya: East Khasi Hills: Elephant falls, 20.ix.2000, Leg. A.P. Singh, 208735-A (LWG). Det. V. Nath, A.K. Asthana & A.P. Singh.

Herbertus sikkimensis (Steph.) Nichols. was instituted by Stephani (1909), under the name *Schisma sikkimensis* Steph., from Sikkim Himalaya. Nicholson *et al.* (1930) and Miller (1965) in a monograph STUDIES ON *HERBERTA* in the Pacific and Asia described this species from Sikkim Himalaya. Moreover, Chopra (1943), Bonner (1966) and Parihar *et al.* (1994) listed *H. sikkimensis* (Steph.) Nichols. from the Eastern Himalaya. Hattori (1966) described *H. sikkimensis* as a synonym to *H. dicranus* (Inoue 1977; Long and Grolle 1990). Pippo (1990) listed it as a synonym of *H. dicranus* from China. However, during a recent study on Indian species of the genus *Herbertus* Gray, Manocha (1999) suggested the independent status of *H. sikkimensis* from *H. dicranus* on the basis of the comparative morphological and ultra microscopic studies of cuticle ornamentation over the leaf surface under SEM. This revealed that *H. sikkimensis* possesses the poorly developed transversely running lamellae over the laminar cells and verrucae arranged in a linear fashion over the vitta cells, while the laminar cells are verrucate but vitta cells show very fine lamellae running parallel to the cell length. The taxonomic account of the present species provided here is based on the study of specimens collected from the various localities of Meghalaya for the first time. The study revealed that

H. sikkimensis approaches to *H. dicranus* (Tayl.) Trev. in possessing secund, spreading to somewhat recurved, decurrent, bifid leaves with acute sinus and slightly curved lanceolate segment with 1/2 twisted, acuminate tip. However, *H. sikkimensis* differs from *H. dicranus* in possessing wider plants, stem and less bifid smaller leaves, smooth vitta cells.

***Herbertus dicranus* (Tayl.) Trev., Inoue, H., Bull. Nat. Sci. Mus., Ser. B (Bot.) 3(1): 9, 1977; Miller, J. Hattori Bot. Lab. 28: 299-412, 1965. (Figs 1, 3)**

Syn.: *Senttnera dicrana* Tayl., in G.L.N., *Syn. Hep.* p. 239. 1845; *Herbertia dicrana* (Tayl.) Trevis., *Mem. R. Ist. Lombardo Sci.* 4: 397. 1877; *Schisma dicranum* (Tayl.) Steph., *Spec. Hep.* 4: 24 (1909).

Plants medium, brown-dark brown, 30 mm long and 1.88 mm wide including leaves. Stem 0.15-0.18 x 0.18 mm in diameter and 9-10 celled across; cortical cells in 2 layers, thick walled, smaller, 5.0 x 5.0-7.5 µm; medullary cells thin walled, larger, 17.5 x 20.0-22.5 µm; frequently branched with numerous attenuated, flagelliform, ventral intercalary branches. Leaves imbricate, secund, spreading to somewhat recurved, decurrent, bifid about 3/5 of the lobe with an acute sinus and slightly curved lanceolate segments with 1/2 twisted, acuminate tips, sinus 1.50 mm deep; leaf lobes 2.25 mm long and 0.83 mm wide; leaf marginal cells 10.0-12.5 x 15.0-17.5 µm, medium thick walled, trigonous; median cells



Fig. 2: *Herbertus sikkimensis* (Steph.) Miller. 1-9. (LWG 208735-A):
 1. Plant ventral view; 2. Cross-section of stem; 3-4. Leaves; 5. Leaf marginal cells;
 6. Leaf median cells;
 7. Leaf basal cells; 8-9. Underleaves.
Herbertus fragilis (Steph.) Miller. 10-19. (LWG 208733-B):
 10. Plant ventral view; 11. Cross-section of stem; 12-14. Leaves; 15. Leaf marginal cells;
 16. Leaf median cells; 17. Leaf basal cells; 18-19. Underleaves



Fig. 3: *Herbertus ceylanicus* (Steph.) Miller. 1-12. (LWG 201208-A):

1. Plant ventral view; 2. Plant magnified view; 3. Cross-section of stem; 4-7. Leaves; 8. Leaf marginal cells; 9. Leaf median cells; 10. Leaf basal cells; 11-12. Underleaves

Herbertus dicranus (Tayl.) Miller. 13-19. (LWG 201215-B):

13. Plant ventral view; 14. Cross-section of stem; 15. Leaf; 16. Leaf marginal cells; 17. Leaf median cells; 18. Leaf basal cells; 19. Underleaf



Fig. 4: *Herbertus mastigophoroides* Miller. 1-10. (LWG 201214-D):
 1. Plant ventral view; 2. Cross-section of stem; 3-5. Leaves;
 6. Leaf marginal cells; 7. Leaf median cells; 8. Leaf basal cells; 9-10. Underleaves

12.5-15.0 x 22.5 µm, slightly thick to minutely thin walled, nodulose trigonous; basal cells or vitta cells very large, 15.0 x 55.0-62.5 µm, trigones nodulose; vitta narrow, concave-depressed, bifid below mid base and disappearing below the tip, leaf cells usually verrucose. Underleaves similar to leaves, generally transversely inserted and a little smaller, 2.00 mm long and 0.70 mm wide, sinus subacute, 1.28 mm deep, lobes lanceolate-acuminate, margin entire.

Distribution and ecology: INDIA: North-eastern Himalaya: Meghalaya: East Khasi Hills: Elephant falls, Langkyrdum Dawki Road, Nepal; China: Taiwan. Plants grow on plant bark and soil in association with *Marchantia polymorpha*, *Riccardia* sp., *Bazzania appendiculata*, *Plagiochila flexuosa*, *Cheilolejeunea serpentina*, *Lopholejeunea subfusca*, *Jungermannia* sp., and *Plagiochila* sp., at 1,385-1,402 m altitude.

Specimens Examined: INDIA: Meghalaya: East Khasi Hills: Elephant falls, 08.iv.1965, Leg. S. Chandra, 201215-B, 201216-A, 201222-D (LWG); Langkyrdum Dawki Road, 07.xi.1998, Leg. V. Nath, A.K. Asthana & A.P. Singh, 206058-E (LWG). Det. V. Nath, A.K. Asthana & A.P. Singh.

Other specimens examined: CHINA: Prov. Yunnan: Yulong Schan prope Urbem Lidjiang, 1915, Leg. Dr. H. Handel Mazzetti, 1136851(F), Cryptogamie exsiccatae editae a Museo Hist. Natur. Vindobonensi Cen. XXXVII Musci, Dec. 81-83, 1355858(F). Det. W.E. Nicholson; CHINA: Chiayico Mt. Alishan near the station, 09.iv.1978, Leg. M.J. Lai, 1029735(F), 10.iv.1978, Leg. M.J. Lai, 1029791(F). Det. M.J. Lai; CHINA: Drakensberg, Solitude resort Van Hayningens pass (foot) Mountain forest, July 1978, Leg. Arnold, 1088988(F); AFRICA COASTALE: Bujongalo (Valle mobuka), 1906, Leg. Tjediz, Deua & Dbrazzi, In the Cryptogamic Herbarium Chicago Natural History Museum, Det. Reurangeri; Taiwan: Between Jichu and Mt. Ari, Chia- Yi Hsien, 26.vii.1977, Leg. M. Michimori, 1029698(F). Det. H. Inoue.

Parihar *et al.* (1994) listed *H. dicranus* from eastern Himalayas and southern India. However, the present study is based on the plants collected from Elephant falls and Langkyrdum forest Dawki road, East Khasi Hills Meghalaya for the first time. This taxon shows similarities with *H. sikkimensis* but distinctly differs in certain features as already mentioned in the discussion part of *H. sikkimensis*. A comparative study of the Meghalaya *H. dicranus* with paratypes showed remarkable variation in morphological features. It has been considered as the adaptation of the plant against diverse environmental habitat.

Herbertus mastigophoroides Miller, *J. Hattori Bot. Lab.*

28: 299-412 (1965). (Figs 1, 4)

Plants long, brown-greenish brown, 50 mm long and

1.55 mm wide including leaves. Stem 0.20 x 0.23 mm in diameter and 11 celled across; cortical cells in 2 layers, much thick walled, smaller, 2.5-5.0 x 5.0 µm; medullary cells thin walled or very slightly thick, larger, 17.5 x 22.5-25.0 µm; frequently branched with numerous ventral intercalary branches. Leaves imbricate to approximate, obliquely inserted, falcate-secund when dry and erect-secund when moist, decurrent, bifid 2/3-3/4 with an acute sinus, lobes lanceolate with acuminate tips, sinus 1.20-1.25 mm deep; leaf lobes 1.75-2.05 mm long and 0.53-0.70 mm wide; leaf marginal cells 12.5-17.5 x 20.0-22.5 µm, thin walled, with nodulose trigones; median cells 10.0-12.5 x 30.0 µm, thin walled, trigones nodulose; vitta cells narrow, slightly grooved, yellowish, bifid nearly to the base, and extending to become the segment tip; leaf cells poorly verrucose. Underleaves similar to leaves but transversely inserted, 1.63 mm long and 0.45-0.53 mm wide, sinus somewhat more rounded, 1.13-1.40 mm deep, lobes divergent, margin entire.

Distribution and ecology: INDIA: North-eastern Himalaya: Meghalaya: East Khasi Hills: Elephant falls. Plants grow on plant bark in association with *Lepidozia* sp., *Bazzania appendiculata*, *Odontoschisma denudatum*, and *Jungermannia* sp., at 1,371 m altitude.

Specimens Examined: INDIA: Meghalaya: East Khasi Hills: Elephant falls, 08.iv.1965, Leg. S. Chandra, 201214-D, 201218-A (LWG). Det. V. Nath, A.K. Asthana & A.P. Singh.

Herbertus mastigophoroides Miller was instituted for the first time by Miller (1965) from Darjeeling, Sikkim Himalaya. Parihar *et al.* (1994) listed *H. mastigophoroides* from eastern Himalaya. The present study is based on the plants collected from Elephant falls, East Khasi Hills, Meghalaya. This species shows resemblance with *H. dicranus* (Tayl.) Miller and *H. sikkimensis* (Steph.) Nichols. in colour, length of the plant, leaf length, nodular trigones and vitta cells. *H. mastigophoroides* differs from *H. dicranus* in possessing stem 11 celled across, 0.20 x 0.23 mm in diameter, leaves 2/3-3/4 bifid, 1.75-2.05 mm long and 0.53-0.70 mm wide, vitta bifid, nearly to the base and extending to become the segment tip. On the other hand *H. sikkimensis* differs from *H. mastigophoroides* in possessing much wider plants (2.50-2.75 mm wide), stem 12-13 celled across, leaves 1/2 bifid, 1.75-1.88 mm long and 0.75-0.80 mm wide; vitta furcate, usually only for a short distance or 1/2 into the lobes having smooth vitta cells.

Herbertus fragilis (Steph.) Miller, *J. Hattori Bot. Lab.*

28: 299-412, 1965; Del. Rosario, R.M., Philipp. *J. Sci.* 104(1-2): 28 (1975). (Figs 1, 2)

Syn.: *Schisma fragile* Steph., *Spec. Hep.* 6: 359, 1922.

Plants small, greenish brown-dull brown, 15-20 mm long and

1.88-2.00 mm wide including leaves. Stem 0.07 x 0.08 mm in diameter and 6 cells across; cortical as well as medullary cells slightly distinct; cortical cells smaller, one layered, thick walled, 5.0-7.5 x 7.5-12.5 µm; medullary cells thin walled, larger, 10.0-12.5 x 15.0 µm; irregularly branched, with both normal and microphyllous branches. Leaves oblong, almost transversely inserted, approximate-imbricate, erect-subspreading, bifid 1/2-2/3 with an open acute sinus and narrowly lanceolate, segments, sinus 0.40-0.46 mm deep, leaf lobes 0.16-0.18 mm wide and 0.60-0.70 mm long; leaf marginal cells 10.0-12.5 x 17.5-22.5 µm, rather thin walled, indistinct to minutely trigonous; median cells 12.5-15.0 x 20.0-22.5 µm, thin walled, trigonous; basal cells or vitta cells 12.5 x 35.0-37.5 µm, distinct, with large nodular trigones; vitta narrow, shallow, grooved, bifid almost to the base and extending to just below the tip; leaf cells poorly verrucose. Underleaves similar to leaves, generally transversely inserted, 0.56-0.60 mm long and 0.15 mm wide, sinus subacute-obtuse, 0.39 mm deep, lobes divergent, lanceolate-acuminate, with entire margin.

Distribution and ecology: INDIA: North-eastern Himalaya: Meghalaya: East Khasi Hills: Elephant falls. Plants grow on rocks in association with *Cephalozia* sp., and *Cephaloziella* sp., at 1,798 m altitude, 23.20 °C temperature and 74% relative humidity.

Specimens Examined: INDIA: Meghalaya: East Khasi Hills: Elephant falls, 20.ix.2000, Leg. A.P. Singh, 208733-B (LWG). Det. V. Nath, A.K. Asthana & A.P. Singh.

Herbertus fragilis (Steph.) Miller was instituted for the first time by Stephani (1922) under the name *Schisma fragile* Steph. from Sikkim Himalaya. Miller (1965) described this species from Sikkim Himalaya. Parihar *et al.* (1994) also listed this species from eastern Himalaya. However, the present study is based on the plants collected from the Elephant falls, East Khasi Hills, Meghalaya for the first time. *Herbertus fragilis* shows resemblance with *H. ceylanicus* (Steph.) Miller, in plant's length, colour, leaf sinus and length, however, latter differs from former in possessing 1.25 mm wide plants including leaves, stem 9 cells across, 0.13 x 0.16 mm in diameter, leaf lobes subobtuse-subacute, not divergent, vitta bifid, nearly to the base and extending to a little bit of sinus, vitta cells smooth.

Herbertus ceylanicus (Steph.) Miller, *J. Hattori Bot. Lab.* 28: 299-412, 1965; Onraedt, M., *J. Hattori Bot. Lab.* 50:191-216 (1981). (Figs 1, 3)

Syn.: *Schisma ceylanicum* Steph., *Spec. Hepat.* 4: 22. 1909.

Plants small to medium, yellowish brown to brown, 15 mm long and 1.25 mm wide including leaves. Stem 0.13 x

0.16 mm in diameter and 9 cells across; cortical cells in 1-2 layers, smaller, thick walled, 5.0-7.5 x 7.5 µm; medullary cells larger, thin walled, 15.0 x 25.0-32.5 µm; frequently branched, branches bearing reduced but otherwise normal leaves for a considerable distance before becoming microphyllous and flagelliform. Leaves imbricate- approximate, subjulaceous when dry and erect spreading when wet, oblong, clasping at the base but not decurrent, 0.60-0.66 mm long and 0.30-0.34 mm wide, bifid about 1/2 with a broadly acute sinus and broad straight acute segments; sinus 0.35-0.45 mm deep; leaf marginal cells 12.5 x 12.5-17.5 µm, thick walled, trigonous; median cells 12.5 x 12.5-20.0 µm, thin walled, trigones nodulose; basal or vitta cells 7.5-10.0 x 32.5 µm, thin walled, with nodular trigones; the vitta cells bifid nearly to the base and extending to a little bit of sinus; leaf cells usually smooth. Underleaves similar to the leaves, 0.60-0.70 mm long and 0.28-0.30 mm wide, sinus acute-subacute, 0.42-0.43 mm deep, lobes less divergent, margin entire.

Distribution and ecology: INDIA: North-eastern Himalaya: Meghalaya: East Khasi Hills: Elephant falls; Sri Lanka. Plants grow on plant bark in association with *Chandonanthus birmensis*, *Cheilolejeunea* sp., *Plagioclila* sp., at 1,385 m altitude.

Specimens Examined: INDIA: Meghalaya: East Khasi Hills: Elephant falls, 08.iv.1965, Leg. S. Chandra, 201205-A, 201208-A (LWG). Det. V. Nath, A.K. Asthana & A.P. Singh.

Herbertus ceylanicus (Steph.) Miller was instituted by Stephani (1909) from Ceylon under the name *Schisma ceylanica* Steph. Miller (1965) described *H. ceylanicus* (Steph.) Miller from Ceylon and stated that there is a specimen of *Schisma ceylanicum* Steph. in Herbarium G (India orientalis in Mte Moolegit, Leg. Fea, 1887, Portion du type). Hattori (1966) described this species from Ceylon and India. Parihar *et al.* (1994) also listed this species from eastern Himalaya. However, the present study is based on the plants collected from Elephant falls in East Khasi Hills, Meghalaya for the first time. The study revealed that the *H. ceylanicus* approaches to *H. fragilis* (Steph.) Miller, but latter differs in having leaves with lunate sinus, lobes more divergent, vitta cells almost to the base and extending to just below the tip.

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